

position. However, wind at Beaufort force 3 may produce sufficient mixing to eliminate the surface layers of air needed to promote abnormal refraction.

The author hopes that these figures will lend credence to the larger values of anomalous dip quoted in modern textbooks,<sup>3</sup> but not apparently observed in studies conducted earlier this century by the Carnegie Institution and the Japanese Hydrographic Office.

## REFERENCES

- <sup>1</sup> Fraser, A. and Mach, W. (1976). Mirages. *Scientific American*, p. 102.  
<sup>2</sup> Wylie, J. (1976). *The Use of Radar at Sea*. Chapter 5. Royal Institute of Navigation, London.  
<sup>3</sup> Bowditch (1984). *American Practical Navigator*, Vol. 1. pp. 437–8. Defence Mapping Agency, Washington.

## KEY WORDS

1. Astronomical navigation.    2. Refraction.    3. Errors and Accuracy.

## ‘A Voyage of Navigational Investigation’

Michael Richey *responds*

I appreciate the comments by Dr. Randles<sup>1</sup> on my original paper,<sup>2</sup> and I readily accept that the historian has to rely on documentation. But it seems reasonable to assume that manuscript or hand-copies of early navigating manuals preceded the printed versions which have come down to us; and no doubt, since it is a craft, many of the practices of navigation will have been imparted from master to apprentice without getting written down at all. It is the balance of probabilities as to what these practices were that has to be weighed up.

*Jester's* voyage of investigation could prove very little. But in saying there was nothing to show that I might not have reached the (English) Channel without altitude observations, Randles seems to have missed what point there was to the investigation. The key passage was the windward leg from Porto Santo to Sta Maria. When the wind heads under sail the navigator seeks to put his vessel on that board which makes up best for the destination; and the less weatherly the vessel, the more important this becomes. Knowing the latitude of Sta Maria I tacked *Jester* when the altitude of the North Star indicated that the port tack would be the more favourable one for reaching the required latitude. It is, of course, conjecture that the early navigator would have done the same thing. But, without any form of position line (from soundings or altitudes) to help him, it is difficult to see how otherwise he could have made the same landfall with the consistency we know he did.

## REFERENCES

- <sup>1</sup> Randles, W. G. L. (1996). ‘A voyage of navigational investigation’. *This Journal*, 49, 285.  
<sup>2</sup> Richey, M. W. (1995). A voyage of navigational investigation. *This Journal*, 48, 349.

## KEY WORDS

1. History.    2. Astro navigation.